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Nutritional composition of fruit of 10 date palm (*Phoenix dactylifera* L.) cultivars grown in Saudi Arabia

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Abstract

The aim of the study was to determine the chemical composition of dates from 10 types of palm cultivated in Saudi Arabia (*Phoenix dactylifera* L.) to assess their nutritive (crude protein, crude fat and ash) and amino acid composition. The dates were rich in sugar (71.2–81.4% dry weight), while ash represented 1.68–3.94%; they contained low concentrations of protein and lipid (1.72–4.73% and 0.12–0.72%, respectively). The predominant mineral was potassium, and the main sugars were glucose and fructose. They contained high concentrations of aspartic acid, proline, alanine, glycine, valine and leucine; low concentrations of threonine, serine, isoleucine, tyrosine, arginine, phenylalanine and lysine and very low concentrations of methionine and histidine. These results show that dates are nutritious and can play a major role in human nutrition and health.

Keywords: Date palm cultivar; Chemical composition; High-performance liquid chromatography

1. Introduction

Saudi Arabia is considered the mother country of the date palm tree, which originated in the country 10 000 years ago. Palm trees were taken from Saudi Arabia to other countries, which were amused by their charm, beauty and endless generosity. Today, Saudi Arabia is the second largest producer of dates in the world, with more than 300 types of date, each with its own taste and texture. Al-Madinah Al-Munawarah is considered the first producer of dates in Saudi Arabia [1]. Fruits of the date palm (*Phoenix dactylifera* L.) is rich in mineral salts and vitamins [2] and is an excellent material for producing refined sugar, concentrated juice, confectionery pastes and fermentation products [3]. Dates contain small amounts of vitamins C, B_1 thiamine, B_2 riboflavin and nicotinic acid [4], and studies have shown that dates have strong antioxidant [5], anticancer [6] and antiviral [7] activities.

The objective of the present work was to determine the chemical composition of 10 types of date with respect to the macro-mineral content and amino acid composition.

2. Materials and methods

2.1. Sample preparation

Seven date palm varieties were grown in Al-Madinah Al-Munawarah and three in El Qaseem, Al-Ola and Riyadh. The commercial varieties tested were Ajwa, Shalaby, Kodari, Anabarah, Sukkari, Suqaey, Safawy,

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Burni, Lobanah and Mabroom (in Tamer stage). The samples used in this investigation were collected from a local market.

2.2. Chemical analyses

The moisture content was determined after drying in a vacuum oven at 70 °C for 48 h [8]. The water activity was measured in a water activity meter (Rotronic). Total nitrogen was determined by the Kjeldahl technique [8], and protein was expressed as the general factor 6.25 [10]. Lipid was determined from dried dates by the Folch method [9]. The ash content was determined from the difference after heating macerated samples of dates in a muffle oven (Ninther band) for 8 h at 600 °C. Sugars were extracted from macerated dates with water at 85 °C and quantified by the 3,5-dinitrosallicylic acid method [10]. K, Fe and Mg were measured by atomic absorption spectrophotometry (ICP AES Ultima 2JY model). Total sugar was determined by high-performance liquid chromatography [8]. Samples were spiked with various combinations of standard sugars (1–5 ppm) to monitor recovery, and the sugar concentration was calculated from peak area measurements [11]. Amino acids were analyzed by the method of Laury Sreinke, with vapour HCl hydrolysis of samples and standards at 110 °C for 19–20 h. After hydrolysis, samples on polyvinylidene difluoride were extracted three times with 100 μL of 40% acetonitrile and 0.5% trifluoroacetic acid, and the extracts were dried completely in a Speed Vac before resuspension in sample buffer. Samples and standards were then analyzed in a Beckman 6300 system [10].

2.3. Statistical analysis

Data were analyzed statistically by analysis of variance, and differences among means were determined for significance at 0.01 in the least-significant difference test [12].

3. Results and discussion

3.1. Chemical composition of date flesh

Table 1 shows the average chemical composition of date flesh from the 10 *P. dactylifera* L. cultivars. The moisture content at the *tamr* stage ranged from 10.5 to 29.5%. Anabarah had the highest moisture content and Labanah the lowest, with no significant difference between Ajwa, Khodari, Sukkari, Safawy and Mabroom. The results are comparable to those reported previously [2,13–15], with some differences related to date variety and agro-climatic and environmental conditions [14,16–19]. The protein content ranged from 1.72 g/100 g dry matter in the Mabroom cultivar to 4.73 g/100 g in Shalaby, indicating relatively little protein; it has been reported previously that dates are not a good source of protein [16]. No significant difference in protein content was observed between two groups of cultivars: Shalaby, Khodari, Labanah and Anabarah and Ajwa, Sukkari, Suqaey, Safawy and Burni. The Mabroom variety had the lowest protein content.

The date flesh samples also had a very low fat content, from 0.12 g/100 g dry matter in Safawy to 0.72 g/100 g in Labanah, which are similar to those reported previously for dates produced in Saudi Arabia [13] and in the

Table 1
Chemical composition (g/100 g dry weight) of date flesh from 10 cultivars.

Date variety	Chemical composition			
	Moisture	Protein	Lipid	Ash
Ajwa	22.8 ± 0.1^{ab}	2.91 ± 0.02^{b}	0.47 ± 0.001^{b}	3.43 ± 0.01^{a}
Shalaby	15.2 ± 0.2^{c}	4.73 ± 0.01^{a}	0.33 ± 0.005^{c}	3.39 ± 0.01^{a}
Khodari	19.5 ± 0.1^{b}	3.42 ± 0.03^{a}	0.18 ± 0.004^{d}	3.42 ± 0.04^{a}
Anabarah	29.5 ± 0.2^{a}	3.49 ± 0.01^{a}	0.51 ± 0.004^{a}	2.33 ± 0.01^{b}
Sukkari	21.2 ± 0.1^{b}	2.76 ± 0.01^{b}	0.52 ± 0.001^{a}	2.37 ± 0.05^{b}
Suqaey	14.5 ± 0.1^{c}	2.73 ± 0.04^{b}	0.41 ± 0.005^{a}	2.29 ± 0.03^{b}
Safawy	23.6 ± 0.3^{ab}	2.48 ± 0.02^{b}	0.12 ± 0.003^{d}	1.68 ± 0.01^{d}
Burni	24.4 ± 0.1^{a}	2.50 ± 0.04^{b}	0.67 ± 0.001^{a}	2.02 ± 0.01^{c}
Labanah	10.5 ± 0.1^{d}	3.87 ± 0.05^{a}	0.72 ± 0.002^{a}	3.94 ± 0.02^{a}
Mabroom	21.3 ± 0.1^{b}	1.72 ± 0.05^{c}	0.27 ± 0.001^{c}	2.79 ± 0.05^{a}

Each value represents the mean ± SE.
Means in the same column followed by the same letter are not significantly different at $p = 0.01$, while those with different letters are significantly different.

Table 2
Sugar content of date flesh from 10 cultivars (g/100 g dry weight).

Date variety	Total sugar	Reducing sugar	Sucrose	Glucose	Fructose	Glu/Fru
Ajwa	74.3 ± 0.2[b]	71.1 ± 0.5[b]	3.2 ± 0.03[c]	51.3 ± 0.3[a]	48.5 ± 0.2[a]	1.05[d]
Shalaby	75.9 ± 0.5[b]	72.6 ± 0.3[ab]	3.3 ± 0.02[c]	50.1 ± 0.1[a]	48.3 ± 0.2[a]	1.03[d]
Khodari	79.4 ± 0.3[a]	74.5 ± 0.1[a]	4.9 ± 0.05[a]	43.5 ± 0.2[c]	40.8 ± 0.2[b]	1.06[d]
Anabarah	78.4 ± 0.2[a]	75.5 ± 0.3[a]	2.9 ± 0.01[d]	51.2 ± 0.5[a]	45.7 ± 0.2[a]	1.12[bc]
Sukkari	78.5 ± 0.1[a]	75.3 ± 0.2[a]	3.2 ± 0.02[c]	52.3 ± 0.1[a]	48.2 ± 0.2[a]	1.08[c]
Suqaey	79.7 ± 0.2[a]	76.5 ± 0.1[a]	3.4 ± 0.03[c]	48.9 ± 0.1[b]	46.3 ± 0.2[a]	1.05[d]
Safawy	75.3 ± 0.1[b]	71.3 ± 0.08[b]	4.0 ± 0.02[b]	45.6 ± 0.3[bc]	38.6 ± 0.2[b]	1.18[b]
Burni	81.4 ± 0.04[a]	78.3 ± 0.1[a]	3.1 ± 0.02[c]	52.3 ± 0.1[a]	47.5 ± 0.1[a]	1.10[c]
Labanah	71.2 ± 0.1[b]	68.2 ± 0.5[b]	3.0 ± 0.03[cd]	37.3 ± 0.2[d]	28.05 ± 0.1[c]	1.32[a]
Mabroom	76.4 ± 0.07[b]	71.2 ± 0.2[b]	5.1 ± 0.1 [a]	51.2 ± 0.1[a]	46.8 ± 0.2[a]	1.16 [b]

Each value represents the mean ± SE.
Means in the same column followed by the same letter are not significantly different at $p = 0.01$ while those with different letters are significantly different.

United Arab Emirates [14] but lower than those in some Iranian varieties (0.4–0.9% of fat). No significant difference in fat content was found in Anabarah, Sukkari, Suqaey, Burni and Labanah dates.

The ash content ranged from 1.68 g/100 g dry matter in Safawy to 3.94 g/100 g in Labanah. No significant differences in ash content were observed between Ajwa, Shalaby, Kodari, Labanah and Mabroom and Anabarah, Sukkari and Suqaey. The dates had a high carbohydrate content (81.6%). It is well known that dates are important sources of sugar, and the total sugar content was similar to that reported previously: 81.6–88.4% [16], 72.8–79.1% [15] and 78.3–87.6% [20]. No significant difference in total sugar content was found between Khodari, Anabarah, Sukkari, Suqaey and Burni and between Ajwa, Shalaby, Safawy and Labanah.

The main sugars found in the date flesh samples were fructose, glucose and sucrose (Table 2); the reducing sugars (glucose and fructose) were the major sugars in all cultivars. The richness of these varieties in reducing sugars suggests the existence of pronounced invertase activity, which considerably reduces its sucrose content [15,20]. The sugar content was lower than those in commercial dates with high sensory quality. Elleuch et al. [15] reported that sugar loss in date by-products could be explained by non-enzymatic browning during storage (Maillard reaction) and rinsing of date flesh samples.

Statistical analysis showed no significant difference in fructose content between Ajwa, Shalaby, Suqaey, Sukkari, Burni, Mabroom and Anabarah and between Khodari and Safawy. There was no significant difference in glucose content between Ajwa, Shalaby, Sukkari, Anabarah, Burni and Mabroom or between Suqaey and Safawy. No significant difference in sucrose content was found between Khodari and Mabroom or between Ajwa, Shalaby, Suqaey, Sukkari and Burni.

3.2. Mineral composition of date flesh

Date fruit contained significant amounts of minerals (Table 3). The potassium concentration was the highest (289.6–512 mg/100 g dry matter), followed in descending order by calcium (123–187 mg/100 g), magnesium (56–150 mg/100 g), phosphorus (12–27 mg/100 g) and sodium (4.9–8.9 mg/100 g). Similar results were

Table 3
Mineral composition of date flesh in four cultivars (mg/100 g dry weight).

Mineral (mg/100 g)	Date variety			
	Ajwa	Kodari	Safawy	Burni
Calcium	187 ± 0.5[a]	133 ± 0.3[c]	123 ± 0.4[c]	168 ± 0.2[b]
Phosphorus	27 ± 0.01[a]	16 ± 0.01[b]	12 ± 0.1[c]	18 ± 0.01[b]
Potassium	476.3 ± 0.4[a]	289.6 ± 0.8[c]	512 ± 0.6[a]	422.5 ± 0.5[b]
Sodium	7.5 ± 0.01[a]	4.9 ± 0.01[b]	8.6 ± 0.1[a]	8.9 ± 0.02[a]
Magnesium	150 ± 0.7[a]	60 ± 0.2[c]	56 ± 0.03[c]	100 ± 0.6[b]

Each value represents the mean ± SE.
Means in the same column followed by the same letter are not significantly different at $p = 0.01$ while those with different letters are significantly different.

Table 4
Amino acid content of date flesh from four cultivars (mg/100 g dry weight).

Amino acid (mg/100 g)	Date variety			
	Ajwa	Khodari	Safawy	Burni
Ala	82	104	105	78
Arg	93	56	37	60
Asp	186	147	127	225
Cys	–	36	32	46
Glu	205	232	158	265
Gly	83	102	98	90
His	26	9	21	27
Iso	44	55	43	45
Leu	57	100	84	82
Lys	73	60	52	51
Met	27	21	18	17
Phe	45	56	54	48
Pro	86	97	110	113
Ser	59	57	64	62
Thr	53	50	51	42
Try	44	–	46	13
Tyr	–	40	15	16
Val	65	78	–	86

reported by Al-Hooti et al. [16], and our results are in close agreement with those of many other studies, which show that dates contain suitable concentrations of calcium, potassium and phosphorus, which are important for metabolism in human cells [13,19,21]. Magnesium and calcium are essential for healthy bone development and for energy metabolism, and iron is essential for red blood cell production. The high potassium and low sodium contents of dates are suitable for people with hypertension [22].

Most of the analyzed minerals showed significant difference among the different varieties, especially for potassium. The variations in magnesium and sodium contents could be explained by factors such as variety, soil type and amount of fertilizer.

3.3. Amino acid composition of date flesh

Dates contain essential amino acids, which the body cannot make and must be provided in the diet [5]. Analysis of the amino acid composition by high-performance liquid chromatography showed that the date extracts contained high concentrations of aspartic acid, proline, glycine, histidine, valine, leucine and arginine but low concentrations of threonine, serine, methionine, isoleucine, tyrosine, phenylalanine and lysine and a very low concentration of alanine (Table 4).

Although the amount of protein was too small for dates to be considered an important nutritional source, dates contain essential amino acids.

4. Conclusion

This study provides baseline information on important date varieties grown in Saudi Arabia. The results show that dates have a high content of sugar (71.2–81.6%) and low concentrations of protein (1.72–4.73%) and lipids (0.12–0.72%). The predominant mineral is potassium, and the predominant sugars are glucose and fructose. These results suggested that dates are nutritious and can play a major role in human nutrition and health. In addition, dates are an important nutritional source of minerals and free amino acids.

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